DIVERSITY, CONSERVATION AND MANAGEMENT OF MAMMALS IN BAGO YOMA, RAKHINE YOMA AND ALAUNGDAW KATHAPA NATIONAL PARK IN MYANMAR

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This investigation was aimed to provide baseline data for the occurrence and diversity of mammals and their conservation status in Bago Yoma, Rakhine Yoma and Alaungdaw Kathapa National Park (AKNP) in Myanmar. Direct and indirect evidences of animals were assessed along transect lines, existing forest trails, waterholes, caves, from animal observation posts, and through village visits. A total of 33 species of mammals was reported across all the regions investigated and an average of 22.3 mammalian species per region was reported. Among these, 21% were classified as endangered, 21% as vulnerable, 7% as Data Deficient as per the IUCN (Menon 2003) Red list status; thus about 50% of the species reported had high conservation significance. Differences in mammalian diversity across all the regions investigated were not statistically significant. For every 5 individuals, a new species of mammal was encountered in AKNP; for Rakhine, this occurred for only every 12 individuals and in Bago for every 9 individuals. The percentage of all mammals, including large mammals and endangered species reported in Rakhine Yoma was high. Although the region surveyed was considered as being rich in mammal diversity, continuing commercial exploitation of the forest for the timber industry, destructive agricultural practices, and unrestricted hunting have resulted in rapid loss of natural habitat and a significant decline of wildlife.

Key words: large mammals, IUCN Red list, habitat modification, hunting, conservation significance

INTRODUCTION

Myanmar, covering a total land area of 677,577 sq. km, is known for its rich floral and faunal diversity (Wint 1993). The country is home to nearly 7,000 species of plants, 300 species of mammals, 1,000 species of birds, about 360 species of reptiles and other taxa, which are poorly documented (IUCN 1989). Conservation of nature is a tradition among the people of Myanmar (Htut 1993). However, wildlife in Myanmar suffered greatly during the Second World War (IUCN 1989; Htut 1993). Even after independence, it suffered a great deal from issues such as insurrection and ineffective law enforcement, and consequently, large mammals, particularly the Asian Elephant *Elephas maximus* and the Tiger *Panthera tigris* today face serious threats for survival (IUCN 1989; Htut 1993), while the Sumatran Rhinoceros *Didermocerus sumatrensis* is very close to extinction (Salter 1983; Rabinowitz and Schaller 1995).

Bago Yoma, located in central Myanmar, has been recognised as being rich in wildlife and containing the largest and most valuable block of Teak forest in the world (Uga 1995). The FAO/UNDP survey carried out in 1981 (FAO 1982) suggested that within Bago Yoma the entire Yenwe catchment upstream of the dam and the rich wildlife habitat in north of Zamari needed protection. Proposing a protected area of not less than 320,000 acres, FAO (1982) recommended that the Yoma be protected as an instance of outstanding landscape and also as a habitat of rare animals, such as the Serow *Nemorhaedus sumatraensis*.

Rakhine Yoma located in the western region of the country has greater number of endangered and vulnerable species, making it a more important region for large mammal conservation (Sayer 1983). According to Sayer (1983), the rugged topography and dense vegetation cover in the Rakhine region made it difficult to hunt animals enabling existence of a diverse animal population. He also felt the reduced presence of settlements/clearings in the forest was due to the low agricultural value of the land.

The Alaungdaw Kathapa National Park (AKNP), located in northern Myanmar still has a large area under forest cover, harbouring the endangered Eld's Deer (*Cervus eldi*) along with other species of large mammals (Tun 1997).

Although the regions have been considered to be rich in mammal diversity, since 1856, under sustainable management of forests, intensive timber extraction has been practiced in these regions. The commercial exploitation of forests on 30 years of felling cycle for 130 yrs for the timber industry have negative effects. In addition, the destructive agricultural practices, and unrestricted hunting have resulted in significant wildlife decline and rapid loss of natural habitats and has resulted in a large area being occupied by Bamboo spp. (Salter 1983; Uga 1995; Tun 1997; Rao *et al.* 2002).

Effective wildlife conservation and management

programs are yet to make an impact in these regions. Only in 1997, 1,775 sq. km (out of 16,000 sq. km area of Rakhine Yoma) area was gazetted as Rakhine Yoma Wildlife Sanctuary (Uga 1995; Rao *et al.* 2002). Under the Bago Yoma Teak Nature Reserve (covering 1,500 sq. km), there was a proposal to preserve the pristine nature of the teak and other forests. To fulfill this objective a survey was conducted in 1983, however, the areas are yet to be brought under the legal management system. AKNP one of the oldest forested regions of the country, was legally gazetted as a Wildlife Sanctuary only in 1984.

Evaluating the status of animals and their habitat in Myanmar is difficult as visibility within the forests is very poor and many of the forests are inaccessible. The survey regions are very remote, with rugged terrain, infested with mosquitoes carrying malaria, and non-existent or extremely poor logistical facilities, making direct observation of animals extremely difficult. However, these regions are very important due to the presence of globally threatened species (Salter 1983; IUCN 1989; Htut 1993). Therefore, observation of tracks, defecation and other signs, along with information collected from local hunters and villagers were used to provide basic data on the occurrence and status of the animal species found in these regions (FAO 1982; Salter 1983; IUCN 1989; Htut 1993; Uga 1995; Rao *et al.* 2002).

For a country like Myanmar, to specifically assess the status of animals found in different regions is never easy given the constraints of time, manpower and other resources available, and the difficulties associated with carrying out a survey in most of the region. A study on the status of the Asian Elephant and its conservation was initiated in Myanmar in the regions of Bago Yoma (formerly known as Pegu Yoma), Rakhine Yoma (formerly known as Arakkan Yoma), and the Alaungdaw Kathapa National Park (AKNP) of northern Myanmar. The areas were chosen as they are considered to be important regions for elephants (FAO 1982; Salter 1983; Htut 1993; Myint 1994; Tun 1997).

The elephant survey provided an opportunity for investigations on the presence and relative abundance of mammalian species, trends of species diversity, similarity and conservation status of mammals and their habitats in these regions. Conservation of mammals, including Asian elephants, in survey regions or for an entire country is possible only through knowing their presence and absence or reviewing the current management status of these regions. The investigation was also aimed at reviewing the establishment of protected areas, staff strength, status of hunting, annual net deforestation rate, legislation to protect mammals and their habitat, law enforcement, budget, and land use polices. Myanmar still contains large areas of relatively intact forest (Rao *et al.* 2005), as one-third of the country's total area is still under forest cover (Aung 2007) coupled with a low human population density and impact (Sanderson *et al.* 2002). Relative importance of these factors and their scope for conservation of mammals and their environment is also discussed through this survey.

MATERIAL AND METHODS

Investigation sites

The investigation sites (Fig. 1) were Bago Yoma (17°-20° N; 96°-97° E), Rakhine Yoma (17°-21° N; 93°-95° E), and Alaungdaw Kathapa National Park (AKNP) (22°-23° N; 94°-95° E). The Bago, Rakhine, and AKNP regions, situated in the central, western and northern regions of Myanmar, respectively, have very extensive tracts of hills. The hill ranges of Rakhine Yoma are a southward extension of the Himalayas. AKNP is in a well-forested mountainous region, situated west of the lower Chindwin river and the Myittha valley. The average elevation of the Bago Yoma is about 700 m; the highest point is 900 m above msl. In Rakhine Yoma, which runs for nearly 600 km, the height ranges between 1,000 and 1,400 m above msl and the average elevation in AKNP is about 1,000 m (ranging between 200 and 1,400 m); steep slopes and narrow ridges characterise all regions.

All these regions have good drainage systems: the Pegu and tributaries of Yenwe Chaung, and the Kun Chaung are the major river sources in Bago Yoma. The Sandoway river (Sandoway Chaung) is the major river system in Rakhine. AKNP is drained by a number of tributaries of the Patolon river, the Petpa Chaung and Taungdwin Chaung being perennial. In all these regions, the wet season lasts from May to October, and is heaviest in August and September. The annual mean rainfall for Bago is 1,700 mm, for Rakhine it is 1,800 mm and for AKNP it is 1,500 mm. In all these regions, the vegetation is largely mixed deciduous forest, with semi-evergreen forests occurring in areas of high precipitation. Patches of evergreen trees consisting, mostly of secondary growth occur in a few places.

The mammalian species reported in these regions include the Rhesus Macaque *Macaca mulatta*, Hoolock Gibbon *Hylobates hoolock*, Phayre's Langur *Semnopithecus phayrei*, Sambar *Cervus unicolor*, Barking Deer *Muntiacus muntjac*, Hog Deer *Axis porcinus*, Eld's Deer *Cervus eldi*, Gaur *Bos gaurus*, Tsaine (Saing) or Banteng *Bos javanicus*, Serow *Nemorhaedus sumatraensis*, Elephant *Elephas maximus*, Sumatran Rhino *Dicerorhinus sumatrensis*, Asiatic Black Bear *Ursus thibetanus*, Malayan Sun Bear *Ursus malayanus*, Leopard *Panthera pardus*, Tiger *Panthera tigris*,

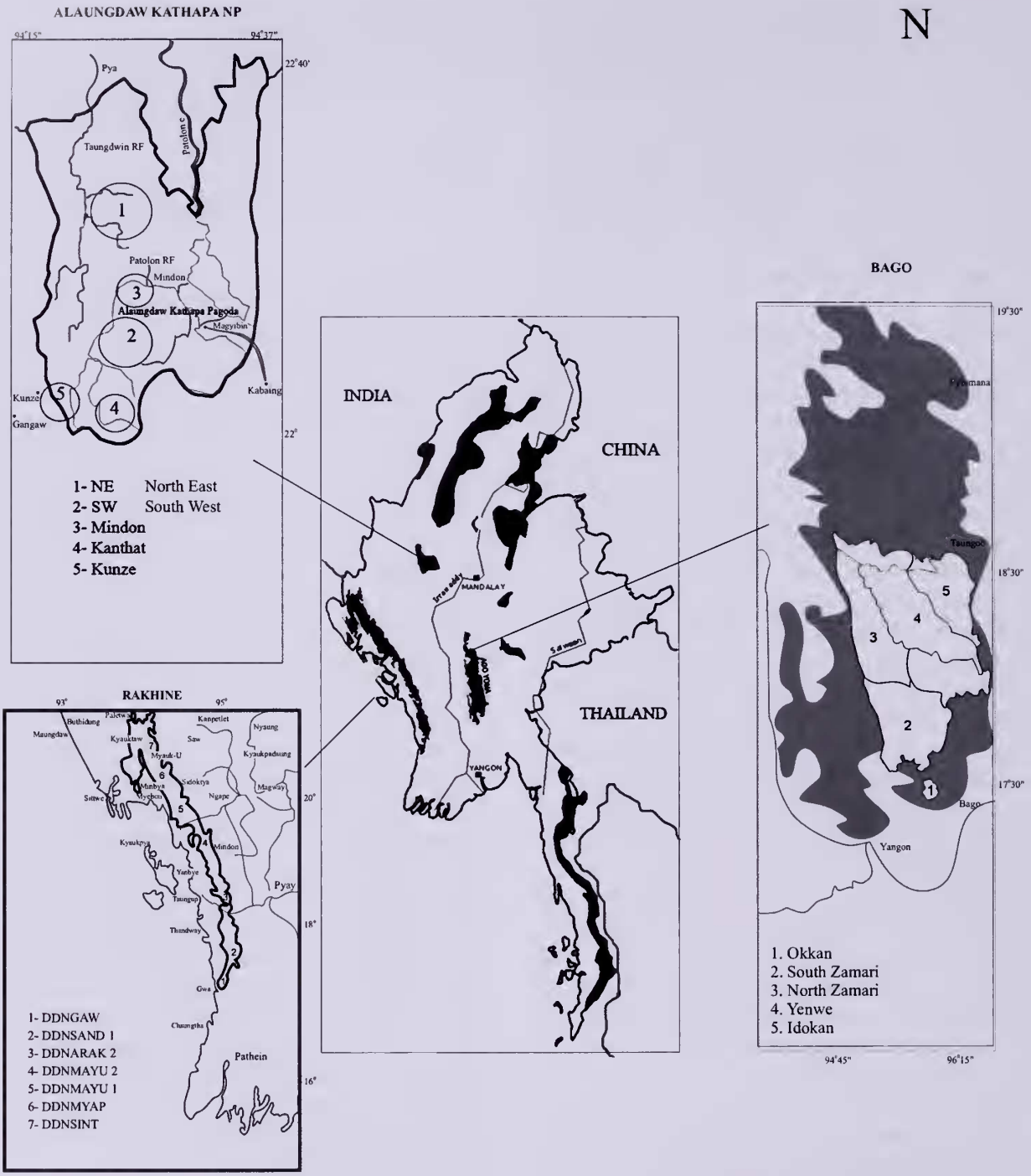

Fig 1: Survey sites in Myanmar: The sites are marked among the forested regions of the country

and Wild Dog *Cuon alpinus*. The sources for the common and scientific names are Corbet and Hill (1992), Yin (1993) and Menon (2003).

Besides the author, the study team for the Bago and Rakhine yoma were drawn largely from the Forest Department and Myanmar Timber Enterprise (MTE), which included Range Forest Officers, Rangers, and Deputy Rangers. In AKNP, the study was conducted with the help of a 14-member expedition team from the UK-based Scientific Exploration Society. Separate training programs for each region were conducted for the teams on various aspects of the investigation. The investigation was carried out in five reserves of the Bago Yoma – 1) South Zamari, 2) North Zamari, 3) Yenwe, 4) Idokan, and 5) Okkan. Seven forest reserves of the Rahine Yoma – 1) Part of Thandwe Reserved Forest (RF) (DDNSAND1), 2) Sabyin and Mindon

area (DDNARAKAN 2), 3) Part of Gwa RF (DDNGAW), 4) North of May Yu RF (DDNMAYU1), 5) south of May Yu RF (DDNMAYU2), 6) Part of Miva Pya (DDNMYAP), and 7) Part of Sin Tanung RF (DDNSINT) were studied. The locations within the AKNP were referred to as South-west (SW), North-west (NW), Mindon, Kunze and Kanthat. In each reserve, the team was split into a number of groups (each consisting of three to four persons, including a field tracker) and data was collected through various methods.

SURVEY METHODS

Line transect method

Direct and indirect evidence of animals was assessed along transect lines to record the species of animals, the number and frequency of occurrence, and their diversity. A total of 142 transects for Bago, 148 for Rakhine, and 22 for AKNP were laid. The length of transects in a particular reserve, within a region, was roughly proportional to the total area of the reserve and lines were well-distributed, covering different regions of the reserves sampled (Table 1). In a given site, not more than three subgroups operated to cut transects, and a minimum distance of 2 km was maintained between two subgroups.

Forest Trail survey method

Existing forest trails were considered for systematic sampling and the start time and end time of every forest or sampling route were noted. During this time, sightings of mammals were recorded through direct and indirect observation (vocalisation, tracks, signs, defecation and other evidence). At every sighting, the time of sighting, name (where possible) and numbers of the animal sighted or indirect evidence was recorded along with other features of the habitat. Whenever possible, the GPS location was noted and acetate transfers of tracks obtained.

Village survey method

The clearest indication of the abundance of wildlife could be obtained from the village survey, for which the systematic approach of a questionnaire-based survey was used in villages situated close to forests. A total of 89 villages were visited for this survey; 76% of the villages were located within the forests and 24% villages were located in a mean distance of 2.88 km (SE = 0.55) from the forests.

Other methods

Specific places such as waterholes, watch towers and animal observation posts were visited. Image Intensifier (II)

Table 1: Forest reserves sampled, area, number and percentage of transects surveyed and distance covered for Bago, Rakhine and AKNP regions

Regions	Name of Reserves	Area sq. km	%	No of transects	%	Distance covered (km)
Bago	South Zamari	882	29.9	36	25.4	72
	North Zamari	714	24.2	35	24.6	70
	Yenwe	795	26.9	36	25.4	72
	Idokan	521	17.6	23	16.2	46
	Okkan	40	1.4	12	8.5	23.5
	Total	**2952**		**142**		**283.5**
Rakhine	DDNSAND 1*	750.5	6.3	16	10.8	32
	DDNARAK 2 *	2600	21.9	70	47.3	140
	DDNGAW *	2600	21.9	20	13.5	40
	DDNMAYU 1*	2652.8	22.4	12	8.1	24
	DDNMAYU 2 *	1200	10.1	8	5.4	16
	DDNMYAP*	1750	14.8	12	8.1	24
	DDNSINT*	307.2	2.6	10	6.8	20
	Total	**11860.5**		**148**		**296**
AKNP	South-west			6	27.3	12
	North-west			4	18.2	8
	Mindon			4	18.2	6
	Kunze			4	18.2	8
	Kanthat			4	18.2	8
	Total	**1606**		**22**		**42**

*Part of Thandwe Reserved Forest (DDNSAND1), Sabyin & Mindon (DDNARAKAN2), part of Gwa Reserved Forest (DDNGWA), north of May Yu Reserved Forest (DDNMAYU1), south of May Yu Reserved Forest (DDNMAYU2), part of Miva Pya (DDNMYAP) and part of Sin Tanung Reserved Forests (DDNSINT).

was used and observations were made by selecting a site, depending on the visibility of the location, with a 50 m radius (The II device works on available light without magnification). Observations were made between 1930 and 2130 hrs. Apart from these methods; observations were also made by waiting for animals near rivers and streams (without II), and on journeys between camps from vehicles or while alighting from vehicles. Signs of animals were also observed in and around the camp, and while creating transects. Caves were visited to observe bats. Mist nets were set up over rivers and within the camp areas, and observers waited for at least an hour at each site, sometimes the wait extending up to two hours.

The ground investigation was initiated in 1995 and was continued till 2000, and the current information (since 2001) on the status of mammals and their habitat was based on personal communications (Uga and Hpone Thant (Harry)), and literature (James *et al.* 1999; Gutter 2001; Rao *et al.* 2002; Bennett and Rao 2002; Sanderson *et al.* 2002; Leimgruber *et al.* 2003, Aung *et al.* 2004; FAO 2004; Rao *et al.* 2005; Lynam *et al.* 2006; Aung 2007). The systematic investigations carried out for Bago were from May 1995 to December 1995, for Rakhine, from December 1995 to May 1996, and for AKNP, only in January 1999. Specific locations of Rakhine and Bago Yoma were investigated again in May 1998 and January 2000 respectively. An attempt to cover the northern Myanmar (regions such as Tamu, Homalin, Tamanthi and Tanai) was made in 2000, but insurgence and other logistic reasons made actual ground investigation impossible. Overall, a total of 8,100 man-hours in Rakhine, 8,500 man-hours in Bago, and 1,350 man-hours in AKNP, respectively, were spent on investigations.

Data analysis

Only the line transect, trail and village investigations provided meaningful observations; though considerable time was spent for observing animals using other approaches (observations with and without II, and using mist nets for bats), they did not provide much scope as number of animals observed through these approaches were substantially low. Results of all these methods were pooled together only to construct a species list, and their presence and absence in the regions sampled. Results of line transect sampling were used for arriving at the frequency occurrence, species diversity and similarity.

Initially, the total number of mammalian species encountered for all the regions together was computed and an overall mean number for species (with standard error – SE and % coefficient of variation – CV) was calculated for each region. Mammals were classified based on their size or weight, or a combination of both, also taking into consideration their mention in literature (Datta 1999; Shankar and Sukumar 1999; Nameer *et al.* 2001). Body length (head to base of tail) was given more importance as the weight of an animal could change depending on its food intake and other factors. Animals above 50 cm were considered large mammals, those between 20 and 40 cm were small/to medium size mammals, and animals below 20 cm were treated as small mammals with body size measurements based on Yin (1993) and Menon (2003).

The percentage of Endangered, Vulnerable and Data Deficient categories of the IUCN Red List (Menon 2003; IUCN 2007) was calculated to arrive at the conservation significance of each survey region. This was done in relation to the occurrence of different categories for all three regions taken together and also individually. Mammalian diversity and other associated parameters for each region were calculated using the computer program BIODIVERSITY Pro (McAleece *et al.* 1997). Diversity and species abundance calculated across the regions were tested using the Kruskal Wallis (Hc) test for significance, through the computer program PAST (Hammer *et al.* 2001).

The number and percentage of similar species shared (based on similarity matrix) across regions were calculated, more specifically large mammal similarity across different regions. This was based on a Bray-Cluster Analysis (Single line) using BIODIVERSITY Pro (McAleece *et al.* 1997). In addition, for each region, the mean percentage (with SE and % CV) of large mammals shared with other regions was calculated. For both these sections, the computation was done in relation to the occurrence of similar species across different regions, and surveys carried out in the same region at different times and in regions that had geographical and ecological similarities.

RESULTS

A total of 33 species of mammals were reported for all the three regions and an average of 22.3 (SE =1.8, CV % 7.9) mammalian species were reported for a region. A total of 15 species (45%) of large mammals was recorded for all the regions investigated, and 93% species were readily identifiable (Prater 1971; Corbet and Hill 1992; Yin 1993; Menon 2003). Among the species identified, 21% were classified as endangered, 21% vulnerable, and 7% belonged to the Data Deficient category of the IUCN Red List status; thus about 50% of the species were reported to have high conservation significance. A total of 14 species (42%) of small to medium sized mammals (Rabinowitz and Schaller 1995) were reported for the regions surveyed; 57% of them were identifiable either to genera or to species; only 42% were

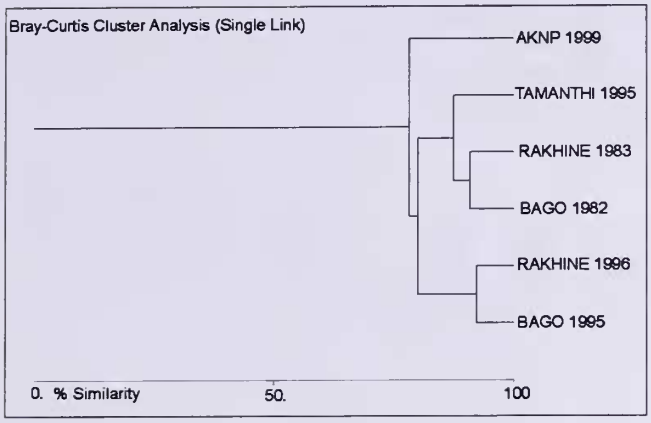

Fig. 2: Large mammal similarity across different regions of Myanmar; the results are based on Bray-Curtis Cluster Analysis (Single Link)

identifiable up to species level. Four species (12%) of small mammals were reported for these regions and none of them were identifiable (Table 2) by specific species name.

Significance of occurrence of mammalian species for different regions

Bago Yoma

A total of 22 species of mammals were identified for the Bago Yoma region (Table 2) of which 82% species were easily identifiable. Among all the species encountered, Barking Deer dominated (35%) for the region, followed by Sambar (17%), Capped Langur (12%), Gaur (9%), and Wild Boar (8%). Overall mammalian diversity value (H') for the region was 2.05 and the equitability value was 0.66 (Table 3). Bago Yoma, under IUCN Red list status, had three species of endangered, two species of vulnerable, and one species under the data deficient category (Table 2).

Rakhine Yoma

For Rakhine Yoma, 25 species of mammals were encountered (Table 2). The pattern of occurrence of different species followed the same trend as Bago Yoma, with the most frequently sighted mammal being the Barking Deer (31%), followed by Sambar (16%), Capped Langur (11%), Gaur (9%) and Wild Boar (8%). Overall mammalian diversity value (H') for the region was 2.18 and the equitability value was 0.67 (Table 3). Rakhine Yoma, under IUCN Red List status, had four species of endangered, three species of vulnerable and one species under the data deficient category.

AKNP

In AKNP, a total of 20 species was encountered (Table 2), of which 82% were readily identifiable. Overall large mammal diversity value (H') for the region was 2.5, and the equitability value was 0.83 (Table 3). AKNP under IUCN Red List status had only one species of endangered, three species of vulnerable, and one species under the data-deficient category (Table 2). The most frequently sighted mammal on all routes was the Gaur, followed by the Sambar, Wild Dog, Barking Deer and Leopard.

On the South-west route, both Gaur and Sambar were sighted with the same frequency. On the North-West route, Gaur was the most frequently sighted animal followed by Sambar and Wild Dog. No sightings or signs of primates were noticed. This could be due to the fact that they had been heavily hunted, or as the forest had been logged, not much tree cover was available for this arboreal taxon. All along the Mindon river, fish poisoning was noticed and the investigation team found bloated fish carcasses along the river.

Trend of species diversity reported across regions

Trend of species diversity and other parameters associated with it are presented in Table 3. The results of the differences across the diversity and abundance values across these regions were not statistically significant (for diversity value Hc=0, $p>0.01$; for abundance Hc=0.38, $p>0.01$) suggesting that mammalian diversity across these regions were equal. While in Rakhine, 18% of individuals were represented by a single species. In AKNP, only 11% individuals represented a single species. For every 5 individuals, one new species was encountered in AKNP, while in Rakhine this occurred in only every 12 individuals and in Bago, for every 9 individuals.

If we consider large mammal diversity and abundance exclusively across the surveyed region, the diversity and abundance were the same in all the regions as the differences were not statistically significant (for diversity, Hc=0, $p>0.01$; for abundance, Hc=0.12, $p>0.01$). Species dominance across Rakhine and AKNP was the same, and in both regions 19% individuals were represented by a single species. For every 8 individuals a new species of large mammal was reported for AKNP, while in Bago it was for every 15 individuals and in Rakhine for only every 19 individuals.

Trend of similar species reported across regions

The investigation results indicated that Bago and Rakhine shared 12 similar species of large mammals, and between Bago and AKNP 8 similar species were reported. The number of similar species shared by Rakhine and AKNP was 9. A specific examination of large mammal similarity across the region, at different times revealed that Bago and Rakhine had a similarity of 92%; while Bago and AKNP had 76%, and Rakhine and AKNP had 78%. Similarly, if one compares similarity over the years, then Bago 1982 and 1995 has species similarity of 69% while Rakhine 1983 and 1996 have 80%

Table 2: Mammal species recorded for the survey regions of Myanmar

S. No	Species category	Scientific name	Mammal	IUCN Red List status	Method of identification	Frequency of occurrence (%)		
						Bogo	Rakhine	AKNP
1	Capped Langur	*Trachypithecus pileatus*	LM	E	Direct	12.3	10.9	0
2	Tiger	*Panthera tigris*	LM	E	Indirect	0.5	0.3	0
3	Elephant	*Elephas maximus*	LM	E	Direct & indirect	0.9	0.6	5.8
4	Hoolock Gibbon	*Hylobates hoolock*	LM	E	Direct & indirect	0	1	0
5	Gaur	*Bos gaurus gaurus*	LM	V	Direct & indirect	9.4	0.7	24.3
6	Himalayan Black Bear	*Selenarctos thibetanus*	LM	V	Indirect	2.4	2.3	1
7	Dhole	*Cuon alpinus*	LM	V	Direct & indirect	0	0.3	7.8
8	Malayan Sun Bear	*Helarctos malayanus*	LM	DD	Direct	0.5	0.3	1
9	Barking Deer	*Muntiacus muntjak*	LM	LR	Direct & indirect	34.9	31.5	5.8
10	Jackal	*Canis aureus*	LM	LR	Direct & indirect	0.5	0.3	0
11	Leopard	*Panthera pardus*	LM	LR	Direct & indirect	0.5	0.3	6.8
12	Sambar	*Cervus unicolor*	LM	LR	Direct & indirect	17.5	16.1	16.5
13	Wild Boar	*Sus scrofa*	LM	LR	Direct & indirect	8.5	7.4	3.9
14	Rhesus Macaque	*Macaca mulatta*	LM	LR	Direct	0.5	0.3	0
15	Monkey	Species unknown	LM	-	Direct	0	0	1
16	Jungle Cat	*Felis chaus*	SMM	LR	Direct & indirect	0.9	0.6	0
17	Mongoose	*Herpestes* sp.	SMM	LR	Direct	0	0.3	5.8
18	Indian Porcupine	*Hystrix indica*	SMM	LR	Direct & indirect	0.5	1.9	1
19	Flying Squirrel	*Petaurista* sp.	SMM	LR	Direct	0.5	0.3	1
20	Indian Otter	*Lutra* sp.	SMM	LR	Direct	0.5	0.3	0
21	Chinese Pangolin	*Manis pentadactyla*	SMM	LR	Direct	0.5	0.3	0
22	Black Giant Squirrel	*Ratufa bicolor*	SMM	LR	Direct	0	0	2.9
23	Javan Mongoose	*Herpestes javanicus*	SMM	LR	Direct	0.5	0	0
24	Civet	Species unknown	SMM	-	Direct	0	0.3	0
25	Hare	Species unknown	SMM	-	Indirect	0.5	0.3	0
26	Squirrel	Species unknown	SMM	-	Direct	7.1	6.1	0
27	Cat	Species unknown	SMM	-	Indirect	0	0	3.9
28	Fishing Cat	Species unknown	SMM	-	Direct	0	0	6.8
29	Fruit Bat	Species unknown	SMM	-	Indirect	0	0	1
30	Bat	Species unknown	SM	-	Direct	0.5	0.3	1
31	Rat	Species unknown	SM	-	Direct	0.5	0.3	0
32	Mouse	Species unknown	SM	-	Indirect	0	0	1
33	Bamboo Rat	Species unknown	SM	-	Indirect	0	0	1.9

LM: Large mammal, SMM: Small-Medium Sized Mammal, SM: Small mammal
LR: Lower Risk, V: Vulnerable, E: Endangered, DD: Data deficient

similarity (Fig. 2).

An average of 72% (SE=8.6) large mammalian species reported for Bago was found in other regions of Myanmar. This includes the survey results of Tamanthi WLS, Rakhine, 1983 and 1996 and Bago 1983. The mean of 80% (SE=7.2) large mammals reported for Rakhine was comparable with other regions of Myanmar (including the 1983 survey by Sayer, in Rakhine).

When the regions were considered together for the differences in large mammals shared among them, the results were not statistically significant (Hc= 4.42, p>0.01). Considering specific regions, the differences across Bago and Rakhine were not significant (Hc= 1.104, p>0.01). A mean of only 61% (SE=5.0) of similar species of large mammals recorded in AKNP were reported for other regions of Myanmar; however, the differences between AKNP and Rakhine (Hc=3.57, p>0.01), and between Bago and AKNP (Hc= 1.87, p>0.01) were not significant.

Conservation Status of the large mammals reported for different regions

The percentage of all mammals, and endangered species (in relation to number of species recorded for each region) reported for Rakhine Yoma was high. The percentage of small mammals, vulnerable species and species under the data deficient category was greater in AKNP (Fig. 3). Bago

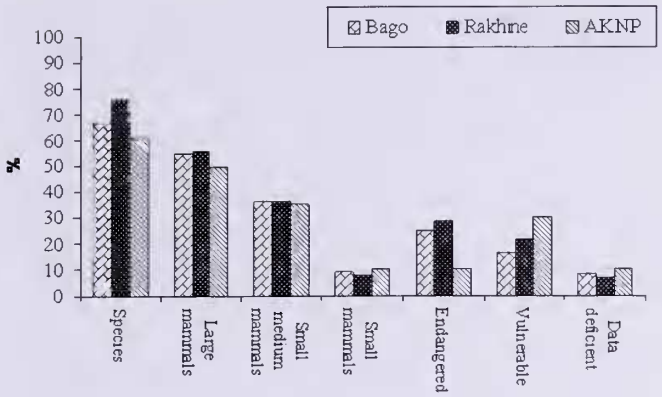

Fig. 3: Conservation status of mammals in different regions of Myanmar. Percentage values are plotted against all species, large mammals, small-medium sized mammals, small mammals and mammals under endangered, vulnerable, and data deficient categories of IUCN red list

contributed more only towards the percentage of small medium-sized mammals and its conservation status could have been equal to Rakhine in terms of the number of species of large mammals, endangered species and number of similar species shared with other regions (Fig. 3).

DISCUSSION

The current investigation results were comparable with that of earlier surveys carried out in Bago and Rakhine (FAO 1982; Sayer 1983) or in a region that has geographical and ecological similarities (Rabinowitz and Schaller 1995). The FAO (1982) survey reported about 17 species of large mammals in Bago with two species of Bear, Elephant, Gaur, Banteng, Eld's Deer (Thamin) and Tiger. Except for the Eld's Deer, Sumatran Rhino, Banteng and Serow, all other species were encountered by the current investigation.

Sayer (1983) reported 16 species of large mammals for Rakhine; except Banteng and the Sumatran Rhino, all other species reported by him have been recorded in the current investigation. A one-month survey carried out in the Tamanthi Wildlife Sanctuary of north Myanmar by Rabinowitz and Schaller (1995) reported 22 species of mammals for the region; of these, 17 were classified as large mammals and 5 species as small to medium sized mammals. Duckworth (1996) reported 30 species for the training and model forest of the Vientiane Forestry College in Laos. His survey reports more of small to medium size mammals with 7 similar species of large mammals occurring in the current investigation regions.

Sayer (1983) and FAO (1982) reported the Sumatran Rhino, Serow, Banteng and Phayre's Langur for both Bago and Rakhine, and FAO reported the Eld's Deer for Bago Yoma; no sighting of these species was reported in this investigation. It is also possible that some of these species have been completely eliminated or numbers have become so low that the sighting probability of these species has been reduced considerably. As mentioned by Rabinowitz and Schaller (1995), the level of human activities along with low law enforcement reported in some of the regions could indicate many large mammals following the path of the Sumatran Rhino towards extinction.

It is also expected that low density and endangered species could be wiped out from some of these regions (Rabinowitz and Schaller (1995). In the past, species considered as problem animals suffered through human-animal conflict. According to FAO 1982, a man-eating problem by tigers was reported in Bago Yoma and several tigers were shot to mitigate this issue. Like the tiger, each species suffers from different problems and their conservation status continues to be speculative. Sightings of tigers through indirect method (Table 2) in Bago and Rakhine Yomas have to be read with caution, as even with the past two decades of extensive efforts by National Park and Wildlife Conservation Division of Myanmar, no evidences of tigers anywhere in Myanmar has been discovered.

The percentage of total man-hours spent for collecting information was not the same across regions; it was maximum for Rakhine followed by Bago and the least for AKNP. This may have had some implication for the species reported for different regions, and it would have been possible to encounter

Table 3: Mammalian diversity and other associated parameters for the study area

		Bago		Rakhine		AKNP	
S.no	Parameters	All category	Only large mammals	All category	Only large mammals	All category	Only large mammals
1	No of species	22	13	25	15	20	10
2	Individuals	212	189	311	278	103	76
3	Dominance D	0.1895	0.2319	0.1635	0.1994	0.1166	0.1936
4	Shannon H	2.054	1.752	2.182	1.887	2.494	1.884
5	Equitability J	0.6644	0.683	0.6779	0.697	0.8324	0.8183

more species for AKNP, if more time had been spent collecting data. Tun (1997) reports species such as Banteng, Serow, Eld's Deer and Capped Langur for AKNP and noted that such species were not encountered during this investigation.

However, the information provided by Tun (1997) was not based on any specific surveys, but was a compilation of species or expected species reported for the region. The species list showed some uncertainty regarding species identification and a confusion of species between the Banteng and the Gaur was reported for the region (Tun 1997). Similarly, there may be some uncertainty for the species reported for AKNP. Another interesting point to be noted is that even with an equal or a slightly greater number of man-hours spent, surveys conducted for regions such as Tamanthi WLS, Rakhine (Sayer 1983) and Bago (FAO 1982) report more species of large mammals than AKNP.

Most of the animals (seen in the forest or visiting crop fields) were hunted, trapped and snared and a significant amount of meat sold in the local markets. Wire snares, simple but very efficient, and locally made traps were used. Porcupine, wild boar, barking deer, sambar, langurs, gaur, sun bears, jungle fowl, hornbills, pheasants, and a variety of other mammals and birds were hunted for meat and other uses. The most obvious indication of abundance of wildlife in Rakhine was the frequency with which game meat was sold at the roadside. Restaurants had abundant supplies of fresh, recently dried meat. Nearly all the forests of the region had been degraded as part of logging and taungya cultivation, but interestingly, this secondary vegetation proved to be the ideal habitat for wildlife.

In all these three regions, no evidence of strong and regular enforcement of law was noticed. A major threat to wildlife in the region surveyed would be the presence of professional hunters. Fish poisoning observed could affect both people and wildlife, being the removal of a valuable protein source from their habitats. Threatened large mammals such as the big cats, deer, gaur, and elephant continue to be in a critical state due to the illegal hunting of these species. In Tamanthi WLS of northern Myanmar, Rabinowitz and Schaller (1995) found people claiming ignorance of the fact that the area was protected under law and people did not understand what such protection meant other than not actively killing wildlife.

A similar trend could have been expected for the areas investigated. Threats to major species in Myanmar are from the escalating prices in the black market for animal products (Rao *et al.* 2005). For instance, illegal markets for tigers also offer scope for tiger prey species and other wildlife species (Bennett and Rao 2002; Rao *et al.* 2005). Recovery of most species of mammals is not possible due to the presence of permanent human settlements, roads and railway lines, cultivated lands, military and insurgence camps (Rao *et al.* 2005).

Current government budget allocation for protected areas may be less than that recommended for effective management (James *et al.* 1999). Legislation to protect both, mammals and their habitats is weak and difficult to enforce (Gutter 2001). Most of the regions need to evolve sensible wildlife management programs and protection, effective patrolling along the entry points of forests, and develop working or management plans, and stopping legal and illegal extraction of forests.

Since 2000, only one wildlife sanctuary has been established in this country, and only one legislation has been enacted (Aung 2007). Myanmar has 39% of paper parks (Braatz *et al.* 1992; Aung 2007) that lack site staff, law enforcement, delineated park boundaries and infrastructures. AKNP with its total area of 1,601 sq. km has only 0.08-forest staff/sq. km and the recently established Rakhine Yoma Wildlife Sanctuary for its 1,756 sq. km has only 0.01 staff/sq. km (Aung 2007). Major threats to the parks in this country during the last two decades have resulted from economic and land use decisions (Aung *et al.* 2004). Most of the landscapes have changed from old growth of forests to a patchwork of degraded secondary growth forest (Aung *et al.* 2004).

The annual net deforestation rate between 1989 and 2000 was 0.2% (Leimgruber *et al.* 2003), with some areas within the country experiencing a more severe rate of loss, which may exceed the global average (Lynam *et al.* 2006). However, although the current forest covers one third of the total land area of the country (Aung 2007), still has relatively low human population and impact (Sanderson *et al.* 2002). Myanmar includes the most extensive wild lands for large mammals in Asia (Leimgruber *et al.* 2003) and the protected area system has grown from less than 1% of the total land area in 1996 to a current level of 7% and there is a proposal to increase it to 10% (Rao *et al.* 2002). The species' richness along with the presence of endangered and vulnerable species, could still lead to all these regions investigated reaching the status of conservation importance. A collective and dynamic conservation approach to save these species will provide long-term conservation scope for these regions.

CONCLUSION

Geographically, Myanmar forms a land bridge between the mainland of continental Asia and Peninsular Malaysia; consequently, it encompasses varied ecosystems, diverse biological resources and geographical features. Myanmar still

has a low human population density. However, the population is increasing alongside numerous developmental activities. This change could cause increased pressure on the biodiversity of this little explored, species-rich region of Southeast Asia. Ironically, there are hardly any studies or even simple surveys of species distribution for most wildlife species. As and when any surveys are carried out on any focal species, it would be very useful to also document information on other species of wildlife in this region. The three regions surveyed represent a small portion of the major habitats in Myanmar and investigation was also restricted to providing some insights on the status of large mammals, and there was no scope for understanding the status of rodents, bats and the elusive, lesser-known, or other mammalian species not known to science. It could be assumed that understanding the status of major species of mammals and conservation of their environment will eventually help in understanding the status of lesser-known but highly diverse mammalian species. The current understanding of the status of mammals in these survey regions may also be motivating factors for future surveys in other regions of the country.

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